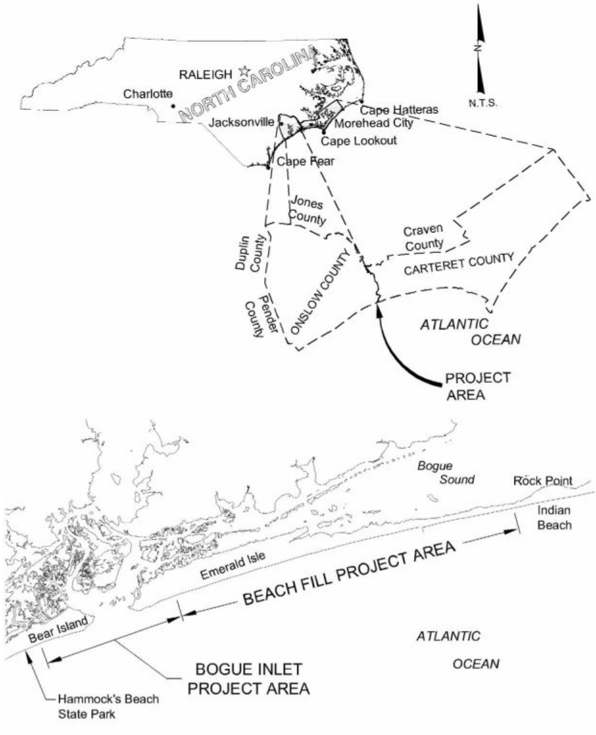


FIGURE 1.1

TOWN OF EMERALD ISLE BOGUE INLET PROJECT LOCATION MAP

2.0 PROJECT IMPACT ASSESSMENT

Two study areas were identified in order to delineate and differentiate between areas anticipated to receive primary and secondary effects (Permit Area/Project Impact Zone) from work occurring within the Inlet and areas anticipated to receive cumulative effects (Project/Survey Area) from work occurring within Bogue Inlet. The Project/Survey Area was developed for the purpose of evaluating each resource and how each resource relates to the proposed action, in terms of determining the significance of the cumulative impacts of the proposed actions on that particular resource. The basis for determining these two study areas were identified from the hydrodynamic modeling results, as well as from the sedimentation analysis conducted for Bogue Inlet. See Appendix A for Permit and Project Area maps.

Engineering and Geotechnical Studies developed for the project show that Islands No. 1 and 2 are eroding in response to the westward movement of the Eastern Channel, as a result of the growth of the Bogue Banks spit. The transient nature of the shoals and islands in Bogue Inlet, and the migratory nature of the White Oak River will make project impacts difficult to determine. Pre- and post-construction digital aerial imagery and field investigations of the low and high marsh will be utilized to assess cumulative effects associated with the project.

3.0 COMPONENTS OF CUMULATIVE EFFECTS ASSESSMENT

Pursuant to the Council of Environmental Quality's (CEQ) regulations (40 CFR §§ 1500-1508) with implementing procedural provisions of the National Environmental Policy Act (NEPA) of 1969 as amended (42 U.S.C. §§ 4321 et seq.) this document includes an assessment of cumulative effects from the proposed channel re-alignment of Bogue Inlet and the affects to resources from other projects. CEQ defines cumulative effects as *the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other action* (40 CFR 1508.7).

The development of the Cumulative Effects Assessment (CEA) utilized both the CEQs "Considering Cumulative Effects Under the National Environmental Policy Act" (1997) and comments from agencies. These documents provide a framework for the analysis, as well as recommendations for addressing cumulative effects.

This assessment will provide an analysis on cumulative effects from the proposed project, as well as affects from other projects. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time. The principle elements associated with the development of the CEA include: 1) identifying environmental resources, ecosystems and human communities; 2) assessment of baseline conditions in the project area; 3) identifying a range of project alternatives and related actions; and 4) analyzing cumulative effects from other projects in the region from both a spatial and temporal scale.

The CEA process is based on three main components of an environmental impact assessment with eleven detailed steps to the analysis. The main components include: 1) scoping, 2) describing the affected environment, and 3) determining the environmental consequences. The eleven step method of the assessment is to assist in finalizing the project alternatives and developing a mitigation plan. Table 3.1 lists the three components and associated steps used to develop cumulative effects analysis.

Table 3.1 Steps in Cumulative Effects Analysis to be Addressed in each Component of the Environmental Impact Assessment (CEQ 1997)

Environmental Impact Assessment Components	Cumulative Effects Analysis Steps
Scoping	1. Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals.
	2. Establish the geographic scope for the analysis.
	3. Establish the time frame for the analysis.
	4. Identify other actions affecting the resources, ecosystems, and human communities of concern.
Describing the Affected Environment	5. Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to change and capacity to withstand stresses.
	6. Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds.
	7. Define a baseline condition for the resources, ecosystems, and human communities.
Determining the Environmental Consequences	8. Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities.
	9. Determine the magnitude and significance of cumulative effects.
	10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects.
	11. Monitor the cumulative effects of the selected alternative and adapt management.

The proposed project has been designed to meet the needs of the present without compromising the ability of future needs. This statement corresponds with the objectives of the World Commission on Environment and Development (1987) and the President's Council on Sustainable Development (1996) in planning for sustainable development.

4.0 CEA STEP 1 – IDENTIFYING CUMULATIVE EFFECTS ISSUES

Step 1 includes a description of potentially affected resources, ecosystems and human communities; identifying the direct and indirect effects of the proposed project; and identifying important effects on the resources from a cumulative effects perspective.

4.1 Potential Affected Resources, Ecosystems and Human Communities

The types of resources identified in the permit area are species and habitat that could be cumulatively affected by the project and associated work. These resources include: Birds, both shorebirds and waterbirds, Federally protected species, piping plover, piping plover critical habitat, seabeach amaranth, and nesting sea turtles; Submerged Aquatic Vegetation (SAV); shellfish habitats; saltwater marsh ecosystem of Dudley Island, west end of Bogue Sound and

Hammocks Beach State Park; shellfish; food resources necessary for the sustainability of species (benthic community); and surface water quality.

4.2 Cumulative Effects Perspective

This section of the CEA discusses whether the proposed activities will have effects similar to other actions in the area and whether the resources within the project area have been historically affected by the cumulative actions of previous projects.

4.2.1 Cumulative Effects to Birds

The primary concerns regarding cumulative effects to shorebirds and waterbirds is habitat loss. The realignment of Bogue Inlet is projected to alter and potentially change the amount of available intertidal shoaling habitat available for foraging, roosting, and nesting. However, habitat loss is expected to be temporary, since replacement of the intertidal shoaling habitat will include the closure of the existing channel and subsequent sand deposition as a result of the sand dike construction.

This assessment includes the assumption that the birds have adapted to the dynamic nature of Bogue Inlet. This project will also add more beach habitat to the west end of Emerald Isle that will be available to shorebirds and waterbirds. The additional beach habitat is considered to be a positive cumulative effect as it provides essential habitat for foraging, nesting, and roosting birds. Therefore, cumulative effects from this project will be positive.

4.2.1.1 Cumulative Effects to Shorebirds

Habitat loss and degradation, disturbance by humans and pets, and increased predation are cited as important causes of the downward population trend of piping plovers (*Charadrius melodus*). According to the U.S. Fish and Wildlife Service (USFWS), the primary threats to piping plovers along the Atlantic coast are habitat modification and destruction and human disturbance which have contributed greatly to the loss of piping plover nesting habitat (USFWS, 2002). Additionally, wintering habitat loss can be attributed to coastal development and inlet and shore stabilization activities (USFWS, 2002). The purpose of many shoreline stabilization projects is the prevention of overwash processes (sediment transport across a barrier island). This process forms inlets and perpetuates the formations of sand and mud flats. These sand and mud flats are used by shorebirds and in Bogue Inlet are designated as critical habitats for wintering piping plovers. Therefore, it may be assumed that there is an important connection between various inlet and shoreline stabilization activities and the formation and maintenance of vital habitat utilized by shorebirds. The USFWS has determined that inlet and shoreline stabilization does affect sand and mud flat habitats used by shorebirds for their wintering grounds. They state that the activities result in permanent habitat loss and direct disturbances to individual birds (Federal Register Part II, 2001). The proposed project is designed to minimize direct and cumulative effects to shorebirds that utilize the area.

Piping plovers usually return to the same wintering sites from year to year. Because piping plovers have high site fidelity, certain factors such as coastal development that can lead to habitat loss, may cause stress to piping plovers. Piping plovers may be forced to relocate to habitats with inadequate prey resources. Burger (1994) states that piping plovers will move to areas not utilized by humans to forage, and he found that dune areas, where human access is restricted, contain higher numbers of foraging piping plovers compared to surrounding ocean and bay areas that are frequented by people. However, intertidal sand flats are preferred by shorebirds. Sand flats, especially those in the middle of the inlet, are usually isolated and therefore, loss of these sand flats can cause significant stress to shorebirds. It is important to note that the intertidal sand flats of Bogue Inlet are naturally dynamic, overwash often, and have varying degrees of persistence. According to Evans (1979) tidal effects are the primary influence on foraging shorebird distribution. The tide affects the amount of area available for foraging and the availability of prey (Recher, 1966; Evans, 1979). During high tide, when intertidal sand and mud flats are unavailable, species of shorebirds move to upland fields or marshes (Heppleston, 1971) or man-made habitats such as fish ponds and salt ponds (Burger, 1984). Shorebirds, such as the piping plover, are adaptable and accustomed to the changing nature of intertidal habitats, and will find suitable habitat if the sand flats in Bogue Inlet change.

The cumulative effects assessment includes several goals. These goals are 1) to provide optimum breeding habitat for the maintenance and growth of priority species, 2) to provide high quality managed habitat for the support of species migrating through or spending the winter in the region, and 3) to restrict human disturbance of shorebirds to the greatest extent possible during the project term. Cumulative project impacts should not result in a net loss of existing habitat and will allow for the natural fluctuation of sand flats. There will be enough protected roosting sites in the project area for shorebirds and stress levels are not expected to increase. Cumulative impact goals should maintain disturbance frequencies below tolerance levels than enable birds to obtain fat storage needed for long-distance migrations.

The Bogue Inlet Relocation Project will not result in long-term habitat loss. The inlet is being returned to the natural historic location that shorebirds used in the mid-70s. To protect these important breeding and wintering habitats, the inlet and shoreline restoration activities will be timed to minimize the direct effects on shorebirds. The project will not cause significant habitat loss or significant stresses that could cause a decrease in shorebird populations. After the construction is finished, especially in the summer months when the inlet is heavily populated with active beach goers in boats and on foot, shorebirds must deal with the additional stress created by human activity in these normally secluded areas. Ultimately, the level of disturbance must be small enough so as not to affect the maintenance of fat reserves used for long-range migration or for maintaining adequate body temperatures under cooler temperatures (Department of Interior, 2001).

4.2.1.2 Cumulative Effects to Waterbirds

The greatest overall threat to waterbirds is a reduction in the quantity and quality of habitat. The microhabitats of Bogue Inlet provide habitat for many species of colonial waterbirds. These microhabitats are important to the conservation of waterbirds, which range from those with no significant concern to those with high management concern as designated in the North American Waterbird Conservation plan (Kushlan and Steinkamp, 2001). Although there is a high diversity of waterbirds in the area, many of the populations are at risk from threats that are mainly habitat-based and affect all aquatic birds and aquatic resources (Kushlan and Steinkamp, 2002).

Kushlan and Steinkamp (2002) found that adult mortality is the most critical demographic parameter in determining population stability. The cumulative effects of this project will not produce negative impacts to adult waterbirds numbers or negative impact to foraging, nesting, and roosting habitats. Cumulative effects must not decrease the quality or quantity of key habitats (intertidal flats and sand spits) for waterbirds. Many of these areas include waterbird nesting and colonizing sites, and the project will avoid loss to any colony sites.

4.2.2 Cumulative Effects to Shellfish

Shellfish are important to the economy of North Carolina; however, shellfish fisheries, especially oysters (*Crassostrea virginicus*), have declined over the years. This decline is due to a decrease in water quality, overharvesting, habitat destruction, disease, and increased predation.

A decrease in water quality can occur from river or stormwater runoff, and paired with solar heating can cause a reduction in dissolved oxygen in waters used by shellfish (Lenihan and Peterson, 1998). Runoff can contribute to sediment loading, nutrient loading, fecal coliform contamination, and the presence of other contaminants that are funneled into areas utilized by shellfish. Because some species of shellfish rely on SAV habitats, persistently high turbidity levels can affect shellfish populations.

Research has shown that stormwater and agricultural runoff are the primary causes of water quality contamination along North and South Carolina coasts (Mallin et al., 2000). Federal and state laws mandate water quality protection activities through government commissions and agencies. Various federal and state resource protection agencies, including the North Carolina Division of Marine Fisheries (NCDMF), evaluate proposed projects and provide comments and recommendations on potential water quality and resource impacts. North Carolina has classified the waters of Bogue Inlet as SA ORW, meaning they are outstanding resource waters suitable for commercial shellfishing and all other tidal saltwater uses (NCDWQ, 2001; NCDWQ, 2002). These waters require more protection and have stringent bacteriological standards due to the pristine conditions of the water needed to sustain healthy shellfish populations.

Shellfish are efficient bio-accumulators that may concentrate harmful organisms, such as bacteria and viruses, when they are present in the water. Fecal coliforms can cause disease in shellfish and can cause bacterial infection in the people that consume them. Chemical contaminants such as heavy metals, hydrocarbons, and pesticides can also affect shellfish. Turbidity particles can also trap nutrients and heavy metals that shellfish can accumulate in their bodies. A consistent range of pH must also be sustained since a change in pH can affect the ability of shellfish to survive and reproduce.

Shellfish can tolerate a wider range of conditions if food is available. Tidal current conditions that are too fast or too slow may affect sedimentation, food availability, removal of biodeposits, transportation of eggs and larvae, growth, recruitment, and water quality. Oysters can use less than 10% of the oxygen available in the feeding currents passing over their gills (Burrel, 1986) and therefore are able to survive in reduced current conditions.

Scallops (*Argopecten irradians concentricus*) grow best in water currents less than 1 cm/s (0.03 ft/s) and maximum growth seems to be achieved at 0.21 cm/s (0.006 ft/s) (Eversole, 1987). Higher velocities (over 12 cm/s [(0.39 ft/s]) result in cessation of growth of bay scallops (Eversole, 1987). It has been shown that the abductor muscles of scallops work more efficiently in slow currents compared to fast currents (Eversole, 1987). Hard clams (*Mercenaria mercenaria*) grow more rapidly in areas with substantial flow (7.5 cm/s [0.24 ft/s]) than in areas with reduced water circulation. Research attributes the increased growth of hard clams in higher flows to increased food availability. Although even in optimum water currents, average growth can decrease if food is not available (Eversole, 1987).

The cumulative effects issues concerning this project involve 1) water quality; 2) habitat alteration; and 3) economic importance of shellfish as a fishery. Water quality is not expected to be significantly influenced by this project. No chemical or biological pollutants will be introduced to the system from this project. Temporary increases in sedimentation may occur, however, not in areas where shellfish are found. If turbidity does increase, levels are expected to remain within the state requirement and will not influence shellfish or the habitats (SAV, oyster rock, etc.) they are utilizing. Dissolved oxygen levels and pH are not expected to be affected by this project.

The project is not expected to decrease water quality or destroy the habitat necessary for shellfish. It has also been shown that mortalities from disease and parasites (e.g. *Perkinsus marinus*) have been attributed to an increase in environmental stresses. Environmental stress lowers shellfish's abilities to resist disease and parasites and can cause death. The project is not expected to increase environmental stress for the shellfish and any effects to shellfish will be temporary and minimal.

4.2.3 Cumulative Effects to the Benthic Community

Impacts to macroinvertebrates and infaunal species and their habitat can have a detrimental affect on the food web. Predators that forage on infauna and macroinvertebrate species include shorebirds and waterbirds, as well as fish species that migrate through the inlet and reside in the nearshore zone.

Sustainability of benthic macroinvertebrates and infaunal species complex habitat can be significantly affected by sediment deposition (Waters, 1995). Suffocation or loss of food sources and habitat can result in the reduction or elimination of benthic communities. A lack of adequate tidal flushing and water flow can contribute to poor water quality conditions for benthic communities, possibly leading to cumulative effects. Hypoxic conditions can also contribute to detrimental effects to infaunal species, since oxygen and pore space of sediments are needed for their survival. The project is not expected to have a negative cumulative effect on the benthic community or the benthic infaunal species since the project will not alter the tidal volume of Bogue Inlet.

4.2.4 Cumulative Effects to Nesting Sea Turtles

In addition to potentially affecting nest selection and construction, beach nourishment may also affect the nest environment. Successful development of embryonic sea turtles is dependent upon the conditions found within the nest environment.

Several important nest cavity factors affecting embryonic development include water content, gas exchange and the temperature of the surrounding sand (Ackerman, 1997). The environment of the nest is influenced by the type, size and sorting of the sand (Crain et al., 1995). Incubation temperature in nests affects the sex ratios of sea turtles and temperature-dependent sex determination occurs around the middle third of incubation (Mrosovsky, 1994). Warmer temperatures tend to produce more females while cooler temperatures produce more males. The pivotal temperature, which marks the transition from males to females, occurs between 28°C and 30°C (82.4°F to 86°F) for sea turtles (Ackerman, 1997). Nest temperatures can be altered by a change in the color of the sand with lighter sand providing cooler incubating temperatures than darker sand. Nourishment projects in the State of Florida that used light colored aragonite sand, mined in the Bahamas, documented incubation temperatures 2ºC (35.6°F) cooler than the natural silicate/calcite sand (Crain et al., 1995). A change in nest temperature may lead to longer incubation times and alter sex ratios of the hatchlings.

Nourished beaches tend to contain more water (Ackerman et al., 1991) than natural beaches. An increase in the amount of water storage may result in an increase in heat retention, which may result in temperature changes within the nest (Ackerman et al., 1991). Thus, the water content of the sand can affect the temperature and atypical sex ratios may result if the nourished beach sand differs significantly from the natural beach in its thermal properties.

The beaches of Bogue Banks and Hammocks Beach State Park are the nesting ground for two species of sea turtles: the loggerhead (*Caretta caretta*) and green sea turtle (*Chelonia mydas*). Since the project is planned to occur between November and March, dredging and nourishment activity should not directly affect nesting female turtles or the emergence and migration offshore of hatchlings. The medium-grained, well sorted material dredged from Bogue Inlet to be used for nourishing the west end of Emerald Isle is similar in characteristics to the native beaches and is expected to have little effect on the success of sea turtle nesting activities. The project site receives sediment from the adjacent barrier islands and is compatible with the existing sea turtle habitat.

4.2.5 Cumulative Effects to Seabeach Amaranth

Cumulative effects to seabeach amaranth (*Amaranthus pumilus*) include beach stabilization structures, beach erosion and tidal inundation, beach grooming, herbivory by insects (webworm) and feral animals and off-road vehicles (USMC, 2003). The plant is able to survive salt spray, poor soil and little fresh water (NPS, 2001).

The construction of seawalls, groins, jetties and other hard structures on the beach has been found to disrupt the natural movement of sand, preventing the creation of new habitat. Available habitat for the plant has been lost due to the installation of these structures north of Cape Lookout. North Carolina state law prohibits the construction of hard structures, which may be why the plant is still found throughout the North Carolina coastline including the three island of the Cape Lookout National Seashore (NPS, 2001).

Randall (2002) found that the cyclical effects of hurricanes on seabeach amaranth to be positive by providing suitable habitat (blown-out dunes and overwash areas) for the plant. He found that hurricanes can uncover dormant seeds buried beneath the sand, which can then proliferate and escape predation in a strained environment.

Nash (2002) found an increase in seabeach plants in both Brunswick County and Bogue Banks, post beach nourishment activities. Nash supported the idea of habitat recovery for seabeach, stating that "prior to the renourishment projects, there was little area of beach where high tides did not reach the toe of the frontal dune so there was no dry sand habitat". He believes that there is a "good seed bank in beach habitat for this plant, but not storm events and lack of habitat prevent establishment". Nash (2002) found the seabeach to be a "prolific seed producer", capable of producing thousands of seeds during one growing season.

The project is expected to have a positive cumulative effect on the seabeach amaranth population by providing additional habitat for the species along both Bear Island and Emerald Isle.

4.2.6 Cumulative Effects to Submerged Aquatic Vegetation

All SAV habitats are found in shallower areas, usually less than two meters, where sufficient light for photosynthesis can penetrate through the water. Light, salinity, substrate, temperature, water currents and wave action all influence the spatial and temporal distribution of submerged aquatic vegetation, with salinity as the primary factor. Cumulative impacts are most typically caused by excessive nutrient loading from non-point source pollution. Excessive nutrient loading can lead to and increase algal blooms resulting in a reduction in water clarity and the ultimate dying off of seagrass beds.

In recent years, eelgrass beds have been declining all along the Atlantic coastline due to agricultural practices. Since federal laws were enacted to protect SAV habitat, large clam and oyster farms (i.e., Virginia and Washington, respectively) have come under heavy regulatory pressure to cease or move these farms because of the potential to interfere with eelgrass beds.

4.2.7 Cumulative Effects to Salt Marsh Ecosystems

The U.S. EPA (2000) has identified global warming and sea level rise as a major factor in the loss of wetlands in the State of North Carolina. North Carolina has 3,375-miles of tidally influenced shoreline, consisting of a long chain of barrier islands, including the Outer Banks, and extensive salt marshes and tidal freshwater marshes that have formed behind these barrier islands (EPA, 2000). The EPA has predicted that the effects of sea level rise will initially cause coastal marshes to expand by spreading onto low-lying terraces, particularly in and around Albemarle Sound. However, further changes in the extent of coastal wetlands will vary with location, with significant loss of wetlands possible in some areas.

Generally, estuarine habitat is being lost or degraded in direct proportion to human population density in coastal areas. Much of the decline of salt marsh has been through alteration to the flow of water to these habitats, such as dams, levees, dikes, dredge and fill operations, drainage, and roadways (NOAA, 2001). The relocation of Mason Inlet resulted in the direct loss of saltmarsh habitat. However, through mitigation and the fact that shoaling areas have become vegetated with salt marsh grasses, no indirect loss of saltmarsh has resulted.

This project is not expected to have a negative cumulative effect on the salt marsh ecosystem since the project will not alter tidal flows to the estuarine habitat and no vegetative communities exist within the proposed channel alignment.

4.2.8 Cumulative Effects to Water Quality

A cumulative effect that is an important aspect of water quality is salinity which is a key factor affecting the distribution of estuarine-dependent SAV, fish, and shellfish. During the year, Bogue Inlet has different periods of high, transitional, and low salinity levels. The realignment of Bogue Inlet is not expected to affect salinity since the project involves only the relocation of the inlet channel and not an alteration of flows or volumes. If changes in salinity occur, the natural variability of the inlet suggests that the flora and fauna are adaptable and capable of surviving a variable salinity regime.

5.0 CEA STEP 2 - GEOGRAPHIC SCOPE

The scope of cumulative analysis for each resource identified in this assessment will differ in their respect to the proposed project and/or projects that have occurred or are projected to occur in the reasonable foreseeable future, which has been defined as 50 years. The spatial boundaries for shellfish, benthic community, submerged aquatic vegetation, coastal marsh, and water quality resources will be localized to the survey or project area. For the bird species, sea turtle nesting habitat, seabeach amaranth, and finfish, the scope of analysis will include all beaches and inlets along the oceanfront of the North Carolina coast.

The geographic boundary of the Bogue Inlet Channel Erosion Response Project includes the Project Area as shown in Appendix A.

6.0 CEA STEP 3 - TIMEFRAME FOR ANALYSIS

The timeframe for the cumulative effects analysis ranges from the earliest construction dates of shoreline and inlet stabilization projects, through the present, to 50 years into the future and reflects the typical planning life of a federal shore protection project. However the temporal boundaries for direct and indirect effects from the project are for three years after construction activities. Based on recommendations provided by the U.S. Fish and Wildlife Service, National Marine Fisheries Service and other members of the Project Delivery Team, the proposed monitoring efforts for the project were extended for three years post-construction to assess the positive and negative effects from the project within that timeframe.

7.0 CEA STEP 4 - OTHER ACTIONS AFFECTING THE RESOURCES

Table 7.1 lists 53 projects and their effect on the resources identified in the geographic scope of the proposed project. These projects were found applicable to this analysis based on their geographic location and type of activity, and were therefore included in this analysis (M. Sugg, pers. comm., 2003). These 53 selected projects were analyzed based on the guidelines provided in the CEQ Handbook for Considering Cumulative Effects (CEQ, 1997).

The projects listed in Table 7.1 were categorized to better associate similar activities involved in projects of the same type, where appropriate (see end of Section 7). This matrix assisted in determining the effects of other actions on a particular resource. The matrix assessment included assigning a type of effect (i.e., D [Direct], I [Indirect] or C [Cumulative]) to the resource based on the available history and nature of the project. The analysts' best professional judgments were used to assess the projects listed in Table 7.1 and the effects of these projects based on the information and resources available. This table takes into account the ability for the resources to respond to change based on the research available. However, due to the age of some of these projects, information on a particular project was not always available to the analyst and therefore a determination was made based on similar project types.

The following is a description of 53 projects (Past, Present, RFFA) identified in the temporal and spatial scope of the Bogue Inlet Channel Relocation Project. The details provided for each project are based on available data which are presumed to be accurate for the purpose of this analysis.

Further correspondence with NCDMF indicated that the projects south of Morehead City could generally be described as having a minimal and indirect effect on shellfish and their resources. There was no confirmation from NCDMF as to whether any of the 53 projects had specific impacts to shellfish, but NCDMF did state that "none of the impacts were major". In general, indirect impacts described by NCDMF included changes in shoaling patterns around the inlet, as well as additional shoaling that reduces the flow of natural channels. In addition, NCDMF could not recall any seagrass impacts caused by the 53 projects and stated that there were no known studies that indicated any impacts. (M. Marshall, pers. comm.) An additional attempt was made to contact NMFS to obtain more specific details on the effects from the 53 projects on SAV and shellfish.

7.1 Inlet Openings

The opening of Drum and Carolina Beach Inlets occurred early in the timeframe analysis associated with this project (1971 and 1952, respectively). Drum Inlet may still have a cumulative effect on the resources identified in this assessment, assuming that the opening of the inlet impacted environmental resources. Based on the information available, analysts have assumed an increase in tidal flows to the estuarine system resulting from each of these projects, which would allow for increased current and water flow to shellfish, SAV, and salt marsh habitat.

Since these projects were conducted over 30 years ago, environmental resources may not have been considered in the project design. Therefore, detrimental cumulative actions to the resources described in this analysis may have occurred but delineation of those effects is not possible given the lack of data on the ecosystems present prior to project construction.

Drum Inlet Opening and Dredging

It is believed that the old Drum Inlet closed naturally in February 1971. In response to the natural closing of the old Drum Inlet, New Drum Inlet was opened 2.5 miles south on December 3, 1971 by the U.S. Army Corps of Engineers Navigation Branch. In 1997, maintenance dredging of the inlet was conducted. After one attempt to maintain the new Drum Inlet, the USACE suspended maintenance dredging. Future maintenance of the new Drum Inlet is highly unlikely. In 1999, after a major hurricane season, the high tides and winds produced by mainly Hurricane Dennis re-opened the old Drum Inlet.

Carolina Beach Inlet Opening

Carolina Beach Inlet was artificially opened in 1952 to improve water quality in the sound north of the inlet. In the early 1930's, the construction of the Atlantic Intracoastal Waterway (AIWW) included a land cut that connected the lower end of Myrtle Grove Sound to the Cape Fear River. At that time, the Cape Fear River was very polluted and when the waters from the Cape Fear River entered the lower part of the sound, siltation and water quality problems resulted. The opening of Carolina Beach Inlet improved water quality conditions north of the inlet but did not improve conditions south of the inlet. The opening of Carolina Beach Inlet also caused significant erosion of the shoreline south of the inlet and the erosion zone migrated about 1.5 miles south of the inlet over a 15 year period with maximum erosion immediately south of the new inlet. Nearly 1,000 feet of shoreline recession was documented immediately south of the inlet over the period from 1952 to 1976. A positive effect of the inlet opening was improved water quality in Myrtle Grove Sound north of the inlet.

7.2 Inlet Closures

The closing of an inlet can have significant cumulative effects on environmental resources. It can be assumed that projects conducted before the 1970’s may not have considered potential effects to environmental resources in the project design. The closure of Moore Inlet, in 1965, eliminated the established flow of water in the area. Since tidal flushing no longer occurred because of the closing of this inlet, water quality may have been negatively impacted by hypoxic or anoxic conditions. If water quality is negatively cumulatively affected, then cumulative negative effects to shellfish, SAV, and salt marsh habitats can result since these resources rely on good water quality conditions. Therefore, it can be assumed that cumulative effects of inlet closures can be negative. The Moore Inlet project did, however, create additional beach habitat, which was available to foraging, nesting, and roosting birds, as well as nesting turtles and for growth of seabeach amaranth.

Moore Inlet Closure

At the time of its closure, Moore Inlet was very shallow (people could walk across it at low tide) and was not a significant factor with respect to circulation and water quality in the Wrightsville Beach area. The USACE Navigation Branch artificially closed Moore Inlet in 1965 using material dredged from the sound to extend Wrightsville Beach and connect it with Shell Island to form a single, continuous barrier island. The biggest impact of the inlet closure was the creation of a convex shoreline between Mason Inlet and Masonboro Inlet. The convex shoreline contributes to relatively high erosion rates along the middle sections of the Wrightsville Beach Storm Damage Protection Project which extends from Masonboro Inlet and extends 14,000 feet to the north. Prior to its relocation, Moore Inlet was located 7,000 feet north of the north end of the Wrightsville Beach project, i.e. 21,000 feet north of Masonboro Inlet.

7.3 Inlet Navigation Projects

Dredging of inlets, especially repetitive maintenance dredging can create stress to various resources in the inlet. Dredging activities stir up sediment in the inlet, which can impact water quality. Depending on the silt content of the dredged material, the decrease in water quality is usually expected to be temporary and thus, not cumulative. In some cases, such as the dredging of Beaufort Inlet, continuous dredging activities may affect sediment transport over long periods of time, which may be considered as a cumulative effect.

For other resources, stress must not increase over the thresholds to which the resources have adapted. For example, to prevent loss to shellfish, SAV, and salt marsh, dredging projects should not cause drastic influences to water quality which can result in cumulative impacts to these resources. Because of the sediment transport from the repetitive maintenance dredging of Bogue Inlet, SAV and salt marsh habitats may be cumulatively affected. However, the silt content of the dredged material in Bogue Inlet is negligible, and therefore, turbidity will be temporarily affected during project construction. This means that the probability of cumulative impacts due to high turbidity levels the Bogue Inlet Channel Response Project is minimal.

Other dredging projects involve placing large amounts of sand onto surrounding beaches using sidecast ocean disposal methods. This provides habitat for birds, nesting turtles, and seabeach amaranth, and can be considered a positive cumulative effect of these resources.

Some projects had negative effects by creating alterations in habitat shoaling, such as the dredging of New River Inlet and New Topsail Inlet. The dredging of New River Inlet in the early 1960's created the formation of offshore shoals which, in turn, could have cumulatively affected shellfish in the area by affecting the flow of water in and out of the inlet. The alteration of tidal flow in an inlet can cause an increase in sedimentation that can then lead to the burial of shellfish beds. Dredging of New Topsail Inlet had the opposite effect on shoaling habitat compared to New River Inlet. The dredging of New Topsail Inlet cleared shoaling habitat which then resulted in the loss of habitat for shorebirds and waterbirds. This can be viewed as a negative cumulative effect for birds that utilize the areas near New Topsail Inlet. Based on the magnitude of positive and negative effects, Table 12.1 shows only a slight cumulative effect on environmental resources from the dredging of the inlets.

Oregon Inlet Dredging and Disposal

Oregon Inlet is located just north of Cape Hatteras and provides a passageway from Pamlico Sound to the Atlantic Ocean. The inlet has dynamically changed naturally since its opening in 1846 and has migrated more than two miles south of its original location. Dredging has been conducted in the inlet since 1962, when the inlet was excavated to -14 feet (MLW). On September 1, 2002 the USACE commenced a new phase of the maintenance dredging project. This project involved pumping approximately 150,000 cubic yards of material onto Pea Island (a National Wildlife Refuge). Recently, material dredged from the entrance channel of Oregon Inlet has been deposited in a nearshore disposal area located immediately offshore of the north end of Pea Island. Future maintenance dredging of the channel is likely with material continuing to be deposited in the Pea Island nearshore disposal area and the Inlet being maintained at -14 feet (MLW).

Hatteras Inlet Dredging

Because Hatteras Inlet lies at a bend in the coast, it is subjected to strong erosion forces that are addressed through periodic maintenance dredge required to maintain safe harbor and inlet navigation conditions. Recent maintenance dredging of Hatteras Inlet occurred in late 1997 and from June 7, 2002 to June 18, 2002. The June 2002 project dredged the Hatteras Inlet Ferry Channel and removed 52,720 cubic yards of sand across the inlet from Cape Hatteras to Ocracoke Island (USACE, 2003).

Beaufort Inlet Dredging

Beaufort Inlet separates Shackelford and Bogue Banks. Between 1936 and 2000, 6,954,000 cy of material has been removed from Beaufort Inlet to construct deeper channels and another 32,717,000 cy has been removed to maintain the navigation and access channels. All of the material until 1997 was placed in ocean disposal areas and essentially removed from the littoral system. Beginning in 1997, approximately one-half of the material removed during maintenance dredging of both the inlet and access channels was placed in nearshore disposal areas located west of the entrance.

Beaufort Inlet is part of the Morehead City Harbor Federal Navigation Project, which involved deepening the harbor in 1961, 1978, and 1994. These dredging events have altered the normal inlet processes of Beaufort Inlet and has greatly modified the inlet morphology. Natural fluctuations in the channel alignment and position, which was a major mechanism that transported sediment across the inlet, no longer occurs. In addition, material removed to maintain the inner harbor is temporarily stored in an upland disposal area known as Brandt Island with material removed from this island every 8 to 10 years and deposited on the east end of Bogue Banks (Atlantic Beach and Fort Macon shorelines). The total length of the beach disposal area is 7 miles beginning at the west side of Beaufort Inlet, however, past disposals have only covered approximately 6 miles of shoreline. Brandt Island has been cleaned out two times, once in 1986 and again in 1994. In all, a total of 8,833,000 cy has been removed from Brandt Island and the inner harbor and deposited on the east end of Bogue Banks. Brandt Island is scheduled to be pumped out again this fall providing sufficient funds are available. The local population is pushing to have all of the dredged material distributed along Bogue Banks from Atlantic Beach west to Indian Beach as part of a Section 933 project. However, Congress and the President have not included the necessary funds in the budget.

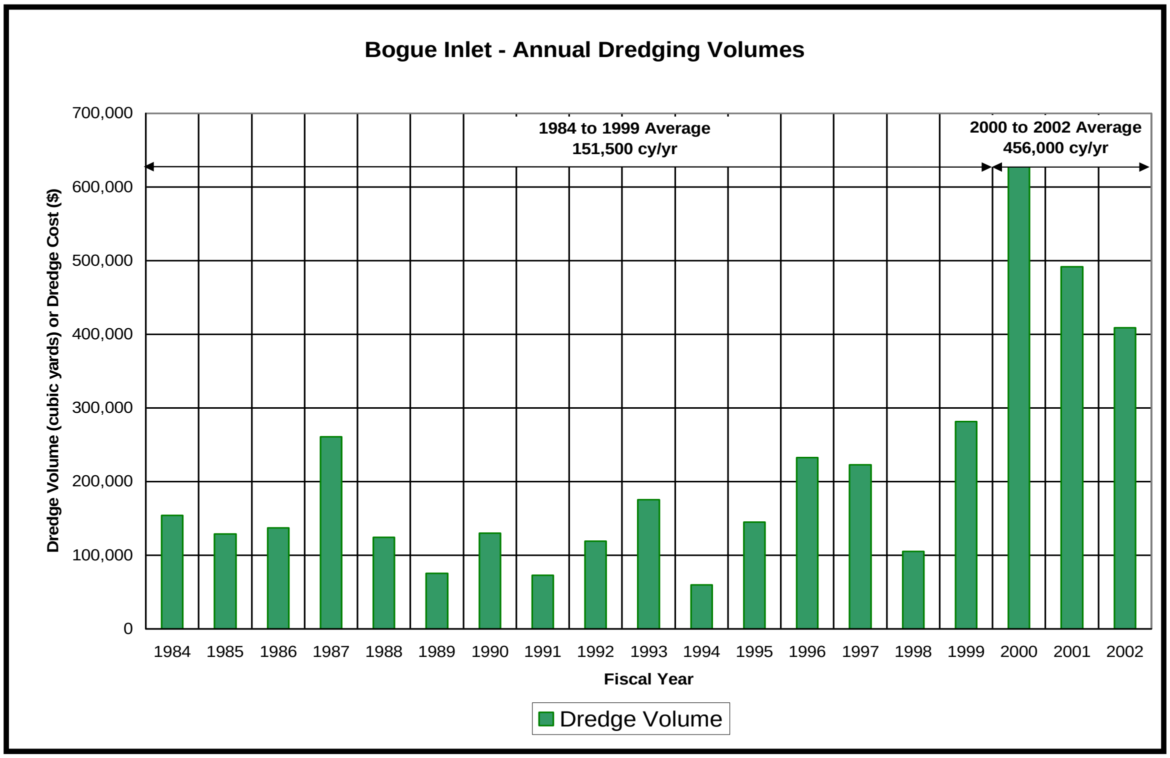
Bogue Inlet Dredging

The navigation channel through Bogue Inlet, which measures 150 feet wide at a depth of 8 feet below mean low water (mlw), was authorized on September 7, 1983 under authority of Section 107 of the Rivers and Harbors Act of 1960. A 90-foot wide by 6-foot mlw deep channel connecting the Atlantic Intracoastal Waterway with the Bogue Inlet gorge was authorized on November 29, 1963 also under authority of Section 107 of the Rivers and Harbors Act of 1960.

Construction of the inlet bar channel was accomplished in 1984 and has been maintained annually primarily with U.S. Government Sidecast dredges MERRITT and FRY. Note that the U.S. Government mini-hopper dredge CURRITUCK was used in 1984, 1985, and 1987. Maintenance dredging of the connecting channel is accomplished by cutter-suction pipeline dredges on an annual basis generally as part of the AIWW inlet crossings contract. Material removed from the Bogue Inlet crossing and the connecting channel in deposited on the west end of Emerald Isle beginning at a point 1,500 feet east of the inlet shoulder.

The material removed from the inlet channel by the sidecast dredges is deposited in the open waters of the inlet between 90 and 100 feet to the side of the dredge. The total volume of material reportedly removed from the inlet channel each year is plotted on Table 7.2.

Table 7.2 Annual Maintenance Dredging – Bogue Inlet – 1984 to 2002



Between 1984 and 1999, maintenance dredging ranged from 60,000 cy/yr to 280,000 cy/yr and averaged 151,500 cubic yards/year. Recently, the amount of maintenance dredging in Bogue Inlet has increased substantially, averaging 456,000 cy/yr between 2000 and 2002. Apparently, the increased dredging activity reflects attempts by the Corps of Engineers to move the channel to the west away from the Pointe shoreline. However, this increased effort has been unsuccessful in moving the channel as it still is positioned immediately adjacent to the Pointe shoreline.

The annual maintenance of the Bogue Inlet crossing and the connecting channel generally involves the removal of between 50,000 cubic yards and 100,000 cubic yards. The disposal of this material on the extreme west end of Emerald Isle is partially responsible for the accretion on this section of the shoreline, however, most of the accretion is due to the position and orientation of the inlet bar channel.

The historic dredging history for Bogue Inlet and the connecting channel provides the base environmental conditions on which to measure the impacts of the proposed Bogue Inlet Channel Relocation project. In this regard, the channel relocation will involve the removal of approximately 1,000,000 cubic yards with 200,000 cubic yards to be used to construct a sand dike across the exiting channel next to the Pointe shoreline and the balance of the material used to nourish 20,000 feet of Emerald Isle shoreline during Phase 3 of the Emerald Isle beach nourishment project. Construction of the sand dike will require direct disposal of the dredged material into the open waters of Bogue Inlet. However, the amount of material involved in the dike construction is less than one-half of the annual volume of dredge material that has been deposited in the inlet open waters between 2000 and 2002. The relocation of the inlet channel will also eliminate the need for annual maintenance dredging of the inlet channel for at least one year and perhaps longer. During the last 3 years (2000 to 2002) the Corps of Engineers has spent an average of $1,132,000/year maintaining the inlet channel.

New River Inlet Dredging

New River Inlet is located along the northern boundary of Topsail Island approximately 30 miles west of Bogue Inlet. The inlet is very shallow and has migrated within a three km wide zone over the past 40 years. Dredging of the inlet began in the 1940's and resulted in an alteration of the hydrodynamics of the inlet. Further dredging in the early 1960's caused the formation of ebb tidal shoals that controlled the shoreline change patterns on the adjacent beaches. The New River Inlet ocean bar channel has been maintained annually since 1965 using USACE Navigation Branch sidecast dredges or the mini-hopper dredge CURRITUCK. Between 1990 and 2000, the reported average amount of material removed from the New River Inlet entrance channel was approximately 335,000 cy. In addition to the entrance channel, the channel connecting the inlet to the AIWW is maintained by pipeline dredge with excavated material being deposited on the north end of North Topsail Beach. Maintenance of this connecting channel has been sporadic with maintenance performed six times between 1976 and 2002.

New Topsail Inlet Dredging

New Topsail Inlet (comprised of Topsail Creek and Banks Channel) has been dredged annually since 1969 with sidecast dredges and the mini-hopper CURRITUCK. The CURRITUCK is used to maintain the inlet channel and contract dredges are used to maintain channels in Topsail Creek and Banks Channel. Between 1992 and 2000, an average of 106,000 cy has been removed from Topsail Creek and Banks Channel and deposited on the south end of Topsail Beach. Topsail Creek and Banks Channel were scheduled for maintenance dredging by a USACE Navigation Branch dredge contractor in December 2002 or January 2003, if funding was available. According to the USACE, Topsail Creek was dredged this year (2003).

Rich Inlet Dredging

This relatively large inlet separates Figure 8 Island, a private residential island, from Hutaff Island, an undeveloped barrier island to the north. The flood tidal delta is highly asymmetric and is bordered by two large channels. Nixon channel, which borders the south side of the Rich Inlet delta, has been dredged periodically with the material used for nourishment of Figure 8 Island. However, the Nixon channel experiences repeated refilling due in part to the expansion of the adjacent flood tidal delta. Local municipalities have expressed interest in dredging Rich Inlet because of the large volumes of sand that may be used for nourishment of adjacent beaches. Figure 8 Island, like Emerald Isle, may seek State and Federal approvals to dredge the inlet channel and use the excavated material for beach nourishment.